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Agricultural Nonpoint Source Pollution and Economic Incentive Policies

Issues in the Reauthorization of the Clean Water Act

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Abstract

The limited success of command-and-control policies for reducing nonpoint source (NPS) water pollution mandated under the Federal Water Pollution Control Act (FWPCA) has prompted increased interest in economic incentive policies as an alternative control mechanism. No single policy, however, is likely to be effective in reducing all NPS pollution. Economic incentives may be effective in some cases, command-and-control practices in others.

Keywords: Clean Water Act, nonpoint source pollution, economic incentive policies.

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Introduction

Congress is debating reauthorization of the 1987 revision of the 1972 Federal Water Pollution Control Act (FWPCA), also known as the Water Quality Act (WQA), which expires in 1992.[1] Much of the debate is expected to focus on nonpoint source (NPS) water pollution, that is, pollution associated with runoff from urban and agricultural lands, and the greater use of economic incentive policies to control it.

This report analyzes existing proposals to reduce agricultural NPS pollution and assesses the opportunities for using economic incentive policies to control it. We review past and current approaches to controlling NPS pollution, such as the command-and-control policies found in the FWPCA, the Clean Water Act (CWA), and the WQA and summarize why these programs have had limited success. We then evaluate proposals that use economic incentives instead of command-and-control measures to manage agricultural NPS pollution. Based on a discussion of the basic characteristics of NPS pollution, we analyze the potential for using economic incentives to control it.

No single policy is likely to be able to effectively control all NPS pollution. Economic incentive policies may work well in some cases, but command-and-control practices will be more effective in others. Thus, an ideal NPS pollution-control strategy would include a variety of policy instruments and the simultaneous use of multiple instruments.

Nonpoint Pollution in the Clean Water Act

Nonpoint sources of water pollution were first targeted for control in the 1972 amendments to the FWPCA. Although the emphasis of the FWPCA was on control of pollution from point sources, section 208 called for the development and implementation of "areawide" water-quality management programs to ensure adequate control of *all* sources of pollutants. The FWPCA directed States to identify NPS problems, to specify controls for remedying them, and to implement appropriate controls. The controls generally took the form of best management practices (BMP's), which were essentially land-use controls and land-management practices. The 1977 CWA further emphasized the

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[1] The FWPCA of 1972, the CWA of 1977, and the WQA of 1987 are 33 U.S.C. sec. 1251 et seq. An initial draft proposal for the reauthorization is United States, 102d Congress, first session, 15 May 1991. S. 1081: Water Pollution Prevention and Control Act.

role of NPS controls in meeting water-quality goals and gave the U.S. Department of Agriculture (USDA) a role in providing technical and financial assistance for water-quality BMP's.

Both the FWPCA and the CWA were largely unsuccessful in reducing NPS pollution.[2] The two acts and the efforts of the Environmental Protection Agency (EPA) focused on controlling point sources of pollution because point sources were perceived as the more serious problem, they were easier to identify, and the technology and funds necessary for control were more readily available. EPA could not readily judge whether State plans were adequate for achieving NPS goals, because information was not available on the extent of NPS pollution and on appropriate control strategies. EPA was not given effective enforcement tools to ensure that NPS management plans were actually implemented (Wicker, 1979).

Congress took a more direct approach to NPS pollution with the WQA of 1987. The WQA placed special emphasis on NPS pollution by amending the CWA's "Declaration of Goals and Policy" to focus on the control of nonpoint sources of pollution (USEPA, 1988). Section 319 of the act requires each State to: (1) identify navigable waters that, without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain applicable water-quality standards or goals, (2) identify nonpoint sources that add significant amounts of pollution to affected waters, and (3) develop an NPS management plan on a watershed-by-watershed basis to control and reduce specific nonpoint sources of pollution. Among other things, the management plan is required to contain a list of BMP's for controlling NPS pollution and a timetable for implementation of the plan.[3]

This approach to controlling NPS pollution differs fundamentally from the approach to controlling point source pollution. For point sources, regulatory responsibility lies primarily with the Federal Government. The FWPCA established the National Pollutant Discharge Elimination System (NPDES), a nationally coordinated permit program for discharges from all point sources, including municipal treatment plants, factories, mines, and large feedlots. Point sources must obtain NPDES permits from EPA or from a State agency that has been given permit-granting authority by EPA. The permits require compliance with effluent limitations that typically specify maximum quantities of pollutants that can be discharged per unit of product output. The effluent limitations are determined by EPA for specific classes of dischargers, and are based on the effectiveness of the best available wastewater treatment technologies. Since the NPDES permits are technology-based, trading of permits across sources is generally not allowed.[4]

Responsibility for NPS pollution control has been left primarily to the States. The Federal Government's role has been restricted to reviewing plans and providing scientific expertise, planning assistance, and funding. There are two major reasons for the limited Federal role. First, solutions to NPS pollution problems, which are a function of past and present land-use decisions, frequently require finding alternative ways to manage land (Greenfield, 1985). Land-use regulation under our constitutional system is among the powers reserved to the States and has traditionally been exercised at the State and local levels.

The second reason for the limited Federal Government role is that management of NPS pollution has relied on a water-quality standards approach, which is based on the State's designated uses of a water body. The controls necessary to meet the designated use standards must be determined at the local level. The large number of variable factors that have to be accounted for in developing a management plan make solutions very site-specific.

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[2]USEPA (1988); Harrington, Krupnick, and Peskin (1985, p.27); and Cook and others (1991).

[3]The WQA also authorized Federal loan and grant funds to help States develop and implement NPS control programs.

[4]An experimental trading program on the Fox River in Wisconsin has not had much success (Apogee Research, Inc.).

Although States have been given wide latitude in choosing policies for addressing NPS problems, State management plans are dominated by three voluntary approaches: education, technical assistance, and cost sharing for water-quality BMP's. Educating farmers about the NPS problem is essential to the success of NPS control programs. Most States provide technical assistance and education to farmers for reducing agricultural NPS pollution. The 1987 Water Quality Act provides some funding for demonstration projects for improving water quality. Similar assistance is also available from USDA.[5]

Seventeen States have in place or are proposing enforceable water pollution control laws dealing with some aspect of agriculture (other than animals) in their section 319 plans. Farmers would be required under such laws to have approved plans for land disturbance (including tillage), to obtain permits for activities that may cause soil erosion or residual discharges to waterways, to comply with established permissible soil-loss limits, and to respond to specific complaints.

Despite these efforts, the overall success of section 319 (or the previous section 208) programs has been limited (USEPA, 1988, Cook and others, 1991). As with the earlier section 208 provisions, the most apparent reason for the failure of section 319 provisions to deal adequately with NPS pollution is the lack of Federal authority to enforce these provisions. While States have been called on to develop NPS programs, clear accountability and responsibility for the programs have not yet been seen at the State level. This is due, in large part, to the lack of an enforcement authority by EPA that would force States to make politically and financially difficult choices. Since the WQA fails to provide sanctions for inadequate progress in developing or implementing section 319 programs, most States rely on voluntary programs that minimize economic effects, even though the programs are unlikely to meet water-quality goals.

New Proposals for Reducing NPS Pollution

The failure to control NPS pollution has prompted Congress and EPA, among others, to call for a major reassessment of the existing approach to controlling NPS pollution in the current reauthorization. Nonpoint source pollution will likely be an important issue of the reauthorization.[6]

A variety of measures have been proposed for dealing with agricultural NPS pollution as well as point sources of agricultural pollution. The measures range from fairly minor modifications of existing policies, such as adding "teeth" to existing section 319 provisions, to substantial revisions, such as developing new, watershed-wide policies that rely on economic incentives (USEPA, 1991a,b). The proposals can be divided into two groups: modifications of existing "command-and-control" type policies, and new economic incentive-based policies. A brief description and evaluation of the main proposals relevant to agriculture are provided below.

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[5]Cost-sharing, available through USDA conservation programs, has been viewed as an effective way of inducing farmers to adopt BMP's. In addition, about half the States have cost-share programs for the installation of soil conservation, nutrient management, or waste-management BMP's.

[6]A number of broad issues and policies have been discussed in the context of the reauthorization. EPA, which has primary responsibility for implementing the act, has emphasized the importance of taking a "whole-ecosystem" approach to tackling environmental problems and of setting environmental priorities based on risks posed to society. In addition, EPA has emphasized the need to prevent pollution at its source, and would like an explicit authority to prevent pollution rather than to just manage it once generated. (See Testimony of William K. Reilly, Administrator, U.S. Environmental Protection Agency, before the Committee on Public Works and Transportation, U.S. House of Representatives, Mar. 20, 1991.) There has been little discussion, however, about how these principles would be put into practice.

Extending NPDES Requirements to Return Flows and Small Feedlots

Some agricultural sources of pollution have been specifically exempted from National Pollution Discharge Elimination System (NPDES) permitting requirements, even though they have certain point source characteristics. Two notable examples are irrigation return flows and small, confined feedlot operations.

Irrigation return flows can carry large quantities of agricultural chemicals and, in arid regions, salts and trace elements.[7] Even though some return flows enter water bodies through specific, identifiable discharge points, they are exempt from NPDES requirements. It has been recommended that these flows be treated like other point sources of pollution and be included in the NPDES program.

Although it may be feasible to effectively impose NPDES controls on some irrigation return flows, it may not be effective for most such flows. Return flows frequently have nonpoint characteristics and enter water bodies over wide areas or via subsurface flows. Even in cases where the flows enter water bodies through ditches, and can be viewed as point sources, institutional factors may make it difficult to regulate them using the NPDES system. For example, return-flow ditches are commonly shared by many farmers, who may belong to different water districts. In such cases, assigning responsibility for obtaining an NPDES permit and complying with its provisions may be difficult.

Small confined feedlot operations are also exempt from NPDES controls. These operations generate wastewater carrying large quantities of bacteria, nutrients, and organic matter that typically enter water bodies through reasonably well-identified discharge points. Proposals have been made to force States to require permits for smaller feedlots, thereby reducing the volume of untreated wastewater discharged by smaller operations (Erwin, 1990).

It is uncertain whether pollution from confined feedlot operations can be effectively managed using NPDES controls. EPA and State environmental agencies have had difficulty developing regulations for feedlots already in the NPDES system. Problems in identifying appropriate technologies and determining suitable effluent limitations are likely to carry over to smaller feedlots. As such, it is questionable whether lowering the cutoff size alone would accomplish much.

Extending Strategy Contained in the 1990 Coastal Zone Management Act

The 1990 amendments to the Coastal Zone Management Act (CZMA) were designed to strengthen State programs for protecting coastal waters.[8] The amendments provide financial incentives for States to comply with Federal requirements and to compel States to establish enforceable measures for controlling nonpoint source pollution, such as mandatory best-management practices and land-use controls. Similar provisions could be incorporated into section 319 of the CWA. Some specific alternatives include:

Linking Federal Funding to State Program Effectiveness. States have made little progress in implementing section 319 provisions. One means of inducing States to take these provisions more seriously is to link the Federal funds they receive to the effectiveness of their section 319 programs.

The threat of reduced Federal funding should give States an incentive to attach more importance to section 319 requirements. Whether it does will depend on the credibility of the threat and on the

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[7]For a discussion of irrigation return flows and agriculture drainage, see Dinar and Zilberman (1991).

[8]Coastal Zone Management Act of 1972, 16 U.S.C. 1451 et seq. See Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990 for the proposed Guidelines Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.

sums of money that are at stake. The CZMA amendment on which this proposal is patterned threatens withholding of Federal section 319 funds only, which are $90 million nationally at present. However, a recent Senate proposal threatens withholding of the more substantial Federal transportation funds for failure to implement section 319 requirements.[9]

Mandating Minimum Enforceable BMP's. Existing State 319 programs rely on voluntary measures, such as education and technical assistance, to encourage adoption of BMP's. These programs have not proven very effective in promoting adoption of BMP's (GAO, 1991, and Cook and others, 1991). An alternative would be to require States to establish a minimum set of enforceable BMP's for agricultural sources contributing to water-quality impairments. Farmers who do not adopt these BMP's would be subject to civil or criminal sanctions. Where necessary, the BMP's would be supplemented by other measures in order to meet water-quality goals. Current proposals do not contain plans to cost-share the mandatory BMP's.

This proposal is perhaps the simplest and most direct approach to achieving some control over agricultural nonpoint pollution. If one assumes that the proposal is politically feasible, its success will depend on the effectiveness of the required BMP's, the ability to monitor compliance, and the vigor of government enforcement efforts. As with other command-and-control type policies, there is no assurance that the controls required would be cost effective, although maintaining farmer flexibility by offering a range of acceptable BMP's would improve cost effectiveness. Imposing a set of minimum requirements on farmers could also complement proposals for developing markets for pollution control.

Deposit/Refund Program for Pesticide Containers

EPA estimates that discarded pesticide containers account for 1.1 million pounds of the 2.2 billion pounds of active ingredient used each year (USEPA, 1991b). Although some of these containers are disposed of legally in regulated hazardous waste facilities, others are not. Uncontrolled disposal of containers may contribute to water contamination as well as other environmental problems. A deposit/refund program for pesticide containers, similar to existing successful programs for beverage containers, could reduce uncontrolled disposal and encourage recycling. The proposed program, which would be quite complicated logistically, would work as follows:

- Retail dealers would pay formulators a deposit when purchasing pesticides. The deposit would depend on the size of a container and/or the toxicity of the pesticide.
- Dealers would pass the deposit on to consumers, who would obtain a refund when they returned containers to dealers.
- Dealers would recover the original deposit when they returned containers to the formulator.
- The formulator would be responsible for recycling the containers or properly disposing of them.

If the deposits are set appropriately, a deposit/refund system would encourage consumers and dealers to collect containers and return them to formulators. Additional controls or incentives may be required, however, to ensure that formulators dispose of the containers, once collected.

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[9]United States, 102d Congress, first session, 15 May 1991. S.1081: Water Pollution Prevention and Control Act.

Point/Nonpoint Source Trading

Another incentive-based proposal that has gained popularity in recent years is establishing markets for pollution reductions (Hahn, 1989). In principle, these markets would achieve desired levels of pollution control at least cost. Market-like policies have been incorporated in the Clean Air Act for point sources of air pollution, in the form of "offset," "bubble," and "banking" provisions (see Tietenberg, 1988, ch. 15). Similar policies could be used to control both point and nonpoint sources of water pollution.

In some watersheds, the costs of further controls on point sources of water pollution are considerably higher than the costs of controlling pollution from nonpoint sources (National Commission on Water Quality, 1976). For these watersheds, it would be cost effective to shift further abatement responsibility from point sources to nonpoint sources. One means of doing this without imposing a financial burden on nonpoint sources would be to let point sources partially or fully subsidize the abatement costs incurred by nonpoint sources--in effect, allowing nonpoint sources to sell or "trade" their pollution reductions to point sources. The potential for such trading is examined in more detail in the next section.

Economic Incentive Policies for NPS Pollution Abatement

Incentive-based policies are designed to provide economic incentives for polluters to reduce the quantity of pollution they generate. This section provides a brief overview of the main issues related to the use of incentive-based policies to control nonpoint source pollution.[10] First, we analyze the fundamental characteristics of nonpoint pollution that complicate the task of designing suitable policies. We then discuss the implications of these characteristics for the use of incentive-based policies. We pay particular attention to the potential for "trading" between point and nonpoint sources of pollution.[11]

Characteristics of Nonpoint Source Pollution

Three basic characteristics distinguish NPS water pollution from point source pollution. First, NPS loadings cannot be monitored at the individual farm or source level, since the loadings enter water bodies over a dispersed area, rather than at fixed, identifiable points. Second, there is imperfect knowledge about the relationship between loadings and farm-level input choices and management practices. Third, loadings depend in part on random variables such as wind, rainfall, and temperature.

Together, these three characteristics imply that an individual farm's loadings cannot be monitored before they enter a water body. And because water bodies are typically common-pool resources that receive loadings from many different sources, the farm's loadings cannot be determined afterward from pollutant concentrations in the receiving water body.[12] Thus, from a regulatory perspective, NPS pollution involves moral hazard in regulation.[13] Although the regulatory agency can judge the quality of a water body through its pollutant concentrations, the agency cannot determine whether the

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[10]Additional discussion of incentive policies for NPS pollution, primarily taxes and liability, can be found in Segerson (1990); Shortle and Dunn (1986); and Braden and Segerson (1991).

[11]Thus, our focus complements existing studies (for example, Segerson, 1990; Shortle and Dunn, 1986).

[12]Estimates of total loadings from all sources may be obtainable.

[13]For a discussion of moral hazard, see Rasmusen (1990, p. 133).

failure of sources to take appropriate actions or undesirable states of nature (high rainfall, for example) caused observed changes in water quality.

These characteristics imply that because the link between farm-level choices and loadings is uncertain, incentive-based policies such as taxes are not necessarily more efficient than command-and-control type policies (Weitzman, 1974). Thus, when confronted with NPS pollution problems, there should be no immediate presumption that economic incentive policies are more efficient than command-and-control policies.

A second implication is that incentive policies cannot be easily defined in terms of individual source loadings.[14] This implies that first-best incentive policies for point sources of pollution, such as effluent taxes, are not well suited to NPS pollution. Thus, policies for individual nonpoint sources must be based, instead, on observable proxies for a source's loadings, such as variable and quasi-fixed input choices (for example, fertilizer, pesticides, irrigation water, management practices, conservation investments, and technology). The success of using proxies for loadings depends on how closely they are related to loadings. For the wide range of NPS pollution problems, there is little empirical information to determine whether policies based on these proxies would provide the desired incentives.[15]

Examples of incentive policies based on observable proxies for a source's loadings are taxes on chemical inputs, tradeable quotas for the same inputs, and subsidies for land retirement or for adopting specific management practices. With the exception of subsidies, these policies have rarely been used in the United States. The debate over the reauthorization has had little discussion to date of taxes or tradeable quotas for chemical inputs. In the case of taxes, this is likely due, in part, to the general public and political aversion to new or increased taxes.[16]

It is not clear, however, that taxes would necessarily reduce input use for all producers. For example, risk aversion can lead to unexpected results when input prices change.[17] If pesticide use raises expected yields and reduces the variance of yields, an increase in a pesticide price due to a tax will not necessarily reduce pesticide use for producers who become less averse to risk as income increases (decreasing absolute risk aversion). A change in a risk-reducing input has two effects: (1) an increase in price reduces wealth, which reduces input use, but (2) the reduction in wealth increases risk aversion, which leads to greater use of pesticides.

Despite showing promise at the theoretical level, tradeable input quotas have received little attention by policymakers. When implemented at the watershed level, tradeable quotas could provide a simple, cost-effective means of limiting chemical input use. And, by initially distributing the quotas for free, the financial burden imposed on farmers could be reduced relative to an equivalent input tax scheme.

A third implication of the characteristics of NPS pollution is that incentive policies based on an aggregate measure of water quality, such as ambient pollution levels, are difficult to understand at a theoretical level and therefore complicated to put into practice. For example, there has been

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[14]In specific situations, such as with irrigation drainage, it may be possible to base policies explicitly on loadings. See, for example, Weinberg and Willey (1991). However, since there are millions of irrigated acres, drainage pricing or some form of tradeable discharge permits would probably have to be defined at some larger unit of aggregation, such as a water district. Thus, such a discharge permit program would probably obtain the desired water-quality effect. The economic efficiency of the program would depend on how within-district allocations are determined.

[15]In some cases, there is a close relationship between input use and loadings, such as between irrigated water use and salt loadings in irrigation drainage.

[16]It may also be due to the very high tax rates needed to achieve significant reductions in chemical input use.

[17]Empirical evidence indicates that farmers are risk-averse. See Love and Buccola (1991).

discussion of using "environmental bonds" to provide economic incentives for firms in a watershed to maintain or improve water quality (USEPA, 1991b). The general idea is that firms would pay a specified sum of money (the bond) that would be returned only if water quality at a future date meets some target level. If the target level is not achieved, the bond fund would be used to finance cleanup activities. Thus, farmers would bear the risk of meeting acceptable water-quality levels.[18]

Two types of environmental bonds have been proposed. The first is essentially a *deposit/refund program* where the size of the "bond" is related to the quantity of input(s) used, such as a fixed sum per unit of nitrogen or phosphorus used. Proposals differ in the criteria for refunding bonds and whether partial refunding is allowed. One suggestion is to link the amount refunded to the level of water quality relative to some target level (the closer to the target, the larger the refund). Another suggestion is to refund the deposit if the farmer can prove that an "approved" best-management practice has been adopted. In the latter case, the refund criterion is independent of actual water quality, and the program is somewhat similar to a BMP cost-sharing program. For example, all farmers in a watershed would pay an up-front cost (the deposit) as well as the cost of the BMP if adopted. The deposit would be cost-shared (that is, refunded) after the fact. If the program was not self-financing, then the cost-sharing rate would be known beforehand. However, if there was a budget constraint for the bond fund to self-finance BMP adoption, the cost-sharing rate would be a random variable since total cost-sharing payments could not exceed the fund, which is a random variable.

The second type of environmental bond is an *assurance bond*, which is a lump-sum payment that is independent of farmer behavior (unlike the deposit/refund system). The value of the bond would be determined by some measure of anticipated environmental damage if the farm maintained its status quo pattern of production. Assurance bonds have been proposed in settings where there is one source (or a very small number of sources) conducting relatively well-defined, one-time activities that may be environmentally damaging. For instance, an assurance bond could be used to give farmers an incentive to create new wetlands to compensate for wetlands that have been drained and cultivated. The cost of creating the new wetlands would determine the size of the bond.

No conceptual or empirical work has been done on how environmental bonds would actually work under the general conditions relevant for NPS pollution. However, several complications with using environmental bonds for NPS pollution limit their general applicability, but also determine the specific circumstances under which they may be viable policy instruments. A main complication is the common-pool characteristic of water bodies, which implies that individual contributions cannot be observed. Since the observed level of water quality depends on the actions of all sources in a watershed, farm-level incentives created by an environmental bond are not straightforward.[19]

A second complication is that, given imperfect capital markets, environmental bonds reduce financial capital available for production and therefore tighten financial constraints on farmers. For the same valued assurance bond, the reduction in wealth due to the bond would be a larger proportion of wealth for small farmers, who may also be most likely to have existing cash-flow problems. Thus, due to the direct reduction in wealth from an assurance bond, farmers below some level of wealth will find the bond too expensive and will abstain from production, even though such production would be socially desirable from a net social-benefit criterion, while those above that level of wealth may continue to find the activity profitable and be willing to post the bond.

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[18]For a discussion of risk sharing and environmental policy in agriculture, see Segerson (1986).

[19]Environmental bonds could be applicable in watersheds with a small number of sources, or in which sources have a history of cooperative action. There are little available data to judge whether these conditions are common.

Most of the observations made above in the context of environmental bonds also hold for liability rules and have been thoroughly analyzed elsewhere.[20] A main conceptual difference between the two is that no up-front payment is made with a liability rule. The size of the liability payment would be determined by the observed impairments of water quality. Liability schemes for NPS pollution management have also been analyzed where firms are given a payment schedule that depends on the observed ambient pollution levels (Segerson, 1988). To implement such a policy, the regulatory agency must know individual abatement cost functions, damage functions, and knowledge of how an individual's abatement efforts affect the distribution of ambient levels. The difficulty and cost of acquiring this information for many producers eliminates the general feasibility of such a policy.

One type of liability, joint and several liability, could have particular relevance in specific NPS settings (Tietenberg, 1989). Under joint and several liability, courts have allowed the government to sue one potentially responsible party (out of many) to pay for damages created by a group of parties. Thus, under joint and several liability, there is no need to apportion damages to each of the potentially responsible parties. This type of liability, however, has been primarily used to finance cleanup of existing toxic waste sites, rather than to provide economic incentives to prevent pollution in the first place. In effect, joint and several liability has been used as a least-cost legal approach for the government to finance toxic waste cleanup, regardless of the equity or economic efficiency implications. As in the case of environmental bonds, strategic behavior among the group of potentially responsible parties is likely to complicate the economic incentives provided by joint and several liability.

Trading Between Point and Nonpoint Sources

Point/nonpoint trading is being considered as an important provision of the reauthorized Clean Water Act. The economic rationale for point/nonpoint trading stems from the difference in abatement costs for the two types of sources: the cost of reducing nonpoint source loadings is, in some cases, lower than the cost of (further) reducing point source loadings.[21] Thus, there may be possibilities for total-cost-reducing trades in loadings between high-cost point source abaters and possibly lower cost NPS abaters.

It is tempting to think of point/nonpoint trading as the creation of a market for pollutant loadings. However, this view of trading is somewhat misleading. Since nonpoint loadings cannot be measured, they cannot be directly traded. In practical terms, "trading" between a point source and an agricultural nonpoint source is likely to entail the following type of transaction:

> *Prototype Trade:* Point source A avoids reducing its loadings by some amount X by paying nonpoint source B to undertake control measures, such as altering its input use, adopting best management practices, or retiring land, that are estimated to reduce its loadings by at least X.

This transaction differs in some important ways from the textbook conception of a transaction in a "pollution rights market," or even from the transaction required in actual point source trading programs, where loadings can be measured directly. These differences are analyzed below.

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[20]See Menell (1991), Brown (1973), Shavell (1984), and Braden and Segerson (1991).

[21]A recent survey of case studies examining the feasibility of point/ nonpoint trading contains the following estimates of the per pound cost of phosphorus reductions: Dillon Reservoir, Colorado--\$860 to \$7,861 (point sources), versus \$119 (nonpoint sources); Upper Wicomico River, Maryland--\$16 to \$88, versus <\$0 to \$12; Honey Creek Watershed, Ohio--\$0.50 to \$10, versus <\$0 to \$34; Boone Reservoir, Tennessee--\$2 to \$84, versus \$0 to \$305. The range of estimates in each case reflects varying stringency of controls or differences among sources (for example, agricultural versus urban sources). See Apogee Research, Inc.

Trading As a Subsidy Scheme

The point/nonpoint "market" is likely to be one-sided unless there are enforceable requirements for abatement by nonpoint sources. In the absence of such requirements, point sources would have to reduce their loadings to be in compliance, but no actions would be required of nonpoint sources. As a result, all the "buyers" in the market would be point sources and all the "sellers" would be nonpoint sources. In this setting, the trading program would effectively be a subsidy scheme, with point sources inducing nonpoint sources to undertake abatement activities by subsidizing their activities.

Some of the standard problems associated with pollution subsidy schemes are likely to arise in the point/nonpoint source trading program (Polinsky, 1979, and Baumol and Oates, 1988). For instance, establishing the appropriate baseline from which to estimate loadings reductions by nonpoint sources is likely to be an issue, given the difficulties in estimating nonpoint loadings. Opportunities may exist for nonpoint sources to adopt especially polluting practices over the period during which baseline loadings are estimated. In the long run, the subsidies received by farmers may reduce their incentives to adopt or develop cheaper, less polluting practices, since this could reduce future subsidies.

These problems could be mitigated, and some eliminated, by imposing minimum enforceable BMP's on nonpoint sources. Baseline loadings could then be defined in terms of the required BMP's. Nonpoint sources would likely be more receptive to proposals for trades from point sources if they already had to implement some controls.

A Government Role

A second distinguishing feature of point/nonpoint trading is the need for close government supervision of transactions. An appropriate authority must determine what control measures (for example, BMP's or land retirement) would reduce nonpoint loadings by the required amount. This determination could not be left to the parties to the transaction, since they would have an obvious incentive to overstate the effectiveness of any proposed measures. Moreover, fairly sophisticated "fate and transport" analyses would have to be conducted to determine the effectiveness of the proposed measures. Neither the point source nor the nonpoint source is likely to have the capability to undertake such analyses.

Uncertainty about the costs of implementing nonpoint control measures is also likely to complicate the trading process. Control measures are likely to call for changes in farming practices and management inputs. Predicting the effects of these changes on farm profits is likely to be more difficult than predicting the costs of installing point source pollution control equipment. Here again, government participation may be necessary to provide credible and accurate estimates of the costs of nonpoint controls.

Conditions for Successful Trading

The object traded in a point/nonpoint trading program is unlikely to be a well-defined, homogenous commodity. As a result, the transaction costs for a trading program are likely to be high, and trading is more likely to resemble a bargaining process than a competitive market. The conditions under which point/nonpoint trading programs are likely to succeed will not be the same as the conditions for the success of competitive markets. It is unlikely that trading would be workable in a setting with large numbers of small point and nonpoint sources because the costs of coordinating the actions of the parties involved would be too high. Trading is more feasible in settings where there are a small number of large point sources and a fairly small number of large nonpoint sources. In such settings, the cost savings from trading are likely to dominate the transaction costs associated with negotiating trades.

Scope for Trading

The above observation raises the issue of the prevalence of the conditions for successful point/nonpoint trading. Although there are no readily available data for judging the "institutional" potential for trading, there is information that can be used to judge the physical potential for trading.[22] For trading programs to be considered, *both* point and nonpoint sources must be major contributors of the problem pollutants in a water body in terms of quantity and timing of loadings. A preliminary EPA analysis indicates that less than 10 percent of all impaired water bodies satisfy this requirement (Apogee Research, Inc., 1992). A recent USDA study that focuses on coastal water bodies reached a similar conclusion (Letson, Crutchfield, and Malik, 1991). Thus, the scope for point/nonpoint trading does not appear to be very broad. Trading, therefore, is an instrument that can play an important, but modest, role in achieving water-quality goals at lower cost in some areas.

The timing of loadings is an important issue for trading. For example, point sources enter water systems at a relatively constant rate, being a function of a production or treatment process. Thus, point source pollution problems increase during low streamflows when assimilative capacity is lowest. NPS pollutants, on the other hand, tend to enter water systems during storms when streamflows and assimilative capacities are greatest. Trading NPS reductions for point source reductions, therefore, may not reduce loadings during low flows when such reductions are most needed.

Conclusions

Voluntary NPS management programs mandated in the CWA have not led to desired levels of water quality in many locations, and significant progress in reducing agricultural NPS should not be expected without changes in the existing approach. Thus, an alternative approach is required, whether based on command-and-control policies, economic incentives, or some combination of the two.

While, along with other proposals, greater use of economic incentive policies is being advocated in the reauthorization of the CWA, this report suggests that the expected effects of individual proposals will be modest. For instance, expanding the scope of the existing NPDES program may be effective in some settings where individual irrigation return flows or discharges from small feedlot operations are easily identified. Similarly, trading between point and nonpoint sources of pollution may be possible in some impaired water bodies where both are major contributors of problem pollutants. A deposit/refund system for pesticide containers may encourage pesticide users to collect containers and return them to formulators.

The review of the distinguishing characteristics of NPS pollution, namely uncertainty and asymmetrical information, underscores that there is no single, ideal policy instrument for controlling the many types of agricultural NPS water pollution. Some of the usual incentive-based policies advocated by economists, such as effluent taxes, are not well suited to the task. As a result, individual incentive policies proposed for the reauthorized CWA, such as pollution trading or deposit/refund systems, may not be broadly applicable for heterogeneous pollution situations. While economic incentive policies may be appropriate in some cases, command-and-control policies may be preferable in others and may in fact complement incentive policies. The choice of instruments should be dictated by the characteristics of the particular pollution problem. Nonpoint source pollution

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[22]The only functioning point/nonpoint trading program is at the Dillon Reservoir in Colorado (a handful of other programs are in the process of being implemented). So far at Dillon, one trade has occurred between a municipal sewage treatment plant and an urban nonpoint source. Two other trades of a similar nature are being considered. Estimates of the cost savings from these trades are not yet available (see Letson, Crutchfield, and Malik, 1991).

control strategies should allow the use of a variety of instruments, as well as the joint use of multiple instruments.

Thus, allowing and encouraging the use of a broad range of instruments for NPS pollution control in the CWA is consistent with the findings in this analysis. Also, while the immediate effects of existing proposals may be modest, they are probably in the desired direction, given the current policy debate. Perhaps more important, implementing a set of modest incentive-based proposals may provide needed information and learning to improve and expand the role of such policies in the future.

References

Apogee Research, Inc. "Incentive Analysis for CWA Reauthorization: Point Source/Nonpoint Source Trading for Nutrient Discharge Reductions." Report for Office of Water, U.S. Environmental Protection Agency, 1992.

Baumol, W., and W. Oates. *The Theory of Environmental Policy*. Cambridge University Press, New York, 1988, ch. 14.

Braden J., and K. Segerson. "Information Problems in the Design of Nonpoint Source Pollution Policy." Paper presented at the 1991 Association of Environmental and Resource Economists' Workshop on the Management of Nonpoint Source Pollution, Lexington, KY, June 1991.

Brown, J. "Toward an Economic Theory of Liability." *Journal of Legal Studies*. Vol. 2, p. 323, 1973.

Cook, K., A. Hug, W. Hoffman, A. Taddese, M. Hinkle, and C. Williams. Center for Resource Economics and National Audubon Society, Statement before the Subcommittee on Environmental Protection, Committee on Environment and Public Works, U.S. Senate, July 17, 1991.

Dinar, A., and D. Zilberman (eds.). *The Economics and Management of Water and Drainage in Agriculture*. Kluwer Academic Publishers, Boston, MA, 1991.

Erwin, M.B. "Agricultural Pollution and the Everglades: A Clean Water Act Solution." *Virginia Environmental Law Journal*. Vol. 10, p. 177, Fall 1990.

Freeman, A. "Water Pollution Policy," in *Public Policies for Environmental Protection* (P. Portney, ed.). Resources for the Future, Washington, DC, 1990.

Greenfield, R. "Controlling Nonpoint Sources of Pollution-The Federal Legal Framework and the Alternative of Nonfederal Action," in *Perspectives on Nonpoint Source Pollution*. EPA 440/5-855-001, U.S. Environmental Protection Agency, May 1985.

Hahn, R. "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders." *Journal of Economic Perspectives*. Vol. 3, p. 95, Spring 1989.

Harrington, W., A. Krupnick, and H. M. Peskin. "Policies for Nonpoint Source Water Pollution Control." *Journal of Soil and Water Conservation*. Vol. 40, p. 27, Jan./Feb. 1985.

Holmes, B. *Institutional Bases for Control of Nonpoint Source Pollution Under the Clean Water Act--With Emphasis on Agricultural Nonpoint Sources*. WH-554. U.S. Environmental Protection Agency, Nov. 1979.

Leathers, H., and J. Quiggins. "Interactions Between Agricultural and Resource Policy: The Importance of Attitudes Toward Risk." *American Journal of Agricultural Economics*. Vol. 73, p. 757, Aug. 1991.

Letson, D., S. Crutchfield, and A. Malik. "Point/Nonpoint Source Trading for Controlling Pollutant Loadings to Coastal Waters: A Feasibility Study." Paper presented at the 1991 Association of Environmental and Resource Economists' Workshop on the Management of Nonpoint Source Pollution, Lexington, KY, June 1991.

Love, H., and S. Buccola. "Joint Risk Preference-Technology Estimation with a Primal System." *American Journal of Agricultural Economics*. Vol. 73, p. 705, Aug. 1991.

Menell, P. "The Limitations of Legal Institutions for Addressing Environmental Risks." *Journal of Economic Perspectives*. Vol. 5, p. 93, Summer 1991.

National Commission on Water Quality. *Report to Congress by the National Commission on Water Quality*. 1976.

Polinsky, A. "Notes on the Symmetry of Taxes and Subsidies in Pollution Control." *Canadian Journal of Economics*. Vol. 12, p. 75, Feb. 1979.

Portney, P. "Air Pollution Policy," in *Public Policies for Environmental Protection* (P. Portney, ed.). Resources for the Future, Washington, DC, 1990.

Rasmusen, E. *Games and Information: An Introduction to Game Theory*. Basil Blackwell, New York, 1990.

Ribaudo, M., and D. Woo. "Summary of State Water Quality Laws Affecting Agriculture," in *Agricultural Resources: Cropland, Water, and Conservation Situation and Outlook Report*. U.S. Dept. Agr., Econ. Res. Serv. AR-23, Sept. 1991, pp. 50-54.

Segerson, K. "Risk Sharing and the Design of Environmental Policy." *American Journal of Agricultural Economics*. Vol. 68, p. 1261, Dec. 1986.

__________. "Uncertainty and Incentives for Nonpoint Pollution Control." *Journal of Environmental Economics and Management*. Vol. 14, p. 87, March 1988.

__________. "Incentive Policies for Control of Agricultural Water Pollution," in *Agriculture and Water Quality* (J. Braden and S. Lovejoy, eds.). Lynne Rienner Publishers, Boulder, CO, 1990.

Shavell, S. "A Model of the Optimal Use of Liability and Safety Regulation." *Rand Journal of Economics*. Vol. 15, p. 271, Summer 1984.

Shortle, J., and J. Dunn. "The Relative Efficiency of Agricultural Source Water Pollution Control Policies." *American Journal of Agricultural Economics*. Vol. 68, p. 668, Aug. 1986.

Tietenberg, T. *Environmental and Natural Resource Economics*. Scott, Foresman and Company, Boston, MA, 1988.

________. "Indivisible Toxic Torts: The Economics of Joint and Several Liability." *Land Economics*. Vol. 65, p. 305, Nov. 1989.

U.S. Environmental Protection Agency. "Nonpoint Sources: Agenda for the Future." Office Of Water, Oct. 1988.

________. "The Cost of Clean Water," notes from a Symposium on Market Forces and Alternative Financing, held at Princeton, NJ, Mar. 1991a.

________. "Economic Incentives: Options for Environmental Protection." Report of the EPA Economic Incentives Taskforce. Mar. 1991b.

________. "Report to Congress: Managing Nonpoint Source Pollution." Apr. 1991c.

U.S. General Accounting Office. *Need for Greater EPA Leadership in Controlling Nonpoint Source Pollution*. GAO/T-RCED-91-60, June 1991.

Weinberg, M., and Z. Willey. "Creating Economic Solutions to the Environmental Problems of Irrigation and Drainage" in *The Economics and Management of Water and Drainage in Agriculture* (A. Dinar and D. Zilberman, eds.). Kluwer Academic Publishers, Boston, MA, 1991.

Weitzman, M. "Prices vs. Quantities." *Review of Economic Studies*. Vol. 41, p. 477, Oct. 1974.

Wicker, W. "Enforcement of Section 208 of the Federal Water Pollution Control Act Amendments of 1972 to Control Nonpoint Source Pollution." *Land and Water Law Review*. Vol. 14, 1979.

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